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BULLETIN

OF THE

TORREY BOTANICAL CLUB

APRIL, 1906

New species of fungi

CHARLES HORTON PECK

Lepiota nudipes

Pileus thin, convex, umbonate, minutely brownish-squamulose, becoming obscurely striate on the margin, whitish, the umbo dark-brown and even; lamellae thin, moderately close, free, ventricose, white; stem slender, fibrous, equal or nearly so, pallid above, brownish and fibrillose below; spores white, elliptic, 5–6 μ long, 3–4 μ broad.

Pileus 1.2–2 cm. broad; stem 2.5–4 cm. long, scarcely 1 mm. thick.

Near St. Louis, Missouri. July. N. M. Glatfelter. Externally this species closely resembles *L. arenicola* Peck, but it is easily separated from it by its much smaller spores. Its smaller size, distinct umbo and obsolete or evanescent annulus separate it from *L. cristata* A. & S. The notes of the collector say "veil none, no odor."

Hygrophorus mephiticus

Pileus thin, convex, becoming plane or nearly so, glabrous, hygrophanous, yellowish-brown and striatulate on the margin when moist, ochraceous when dry, sometimes tinged with green, flesh whitish, sometimes tinged with yellow, odor mephitic; lamellae broad, thick, unequal, distant, sinuate, adnexed, sometimes connected by veins, often wavy, grayish-violaceous or grayish-purple; stem equal or tapering at the base, curved or flexuous, brittle, hollow, colored like or a little paler than the pileus, often with a whitish mycelioid tomentum at the base; spores white, elliptic, 8–12 μ long, 6–7 μ broad.

Pileus 2–4 cm. broad; stem 3–5 cm. long, 2–5 mm. thick.

[The BULLETIN for March 1906 (33: 128–211, *pl.* 6–9) was issued 7 Ap 1906.]

Among sphagnum in swamps. Stow, Massachusetts. August, 1905. S. Davis. This is a peculiar and well-marked species, easily recognized by its unusual colors, odor and habitat. The odor persists several days after the plants have been collected; its similarity to that of a skunk has suggested its specific name.

Collybia brunnescens

Pileus thin, broadly convex, sometimes slightly umbonate, glabrous, subpruinose, grayish-brown; lamellae thin, close, emarginate, whitish or cream-colored; stem equal or slightly thickened at the base, striate, glabrous, solid or stuffed, white; spores white, elliptic, 8–10 μ long, 5–6 μ broad.

Pileus 2–7 cm. broad; stem 3–5 cm. long, 4–6 mm. thick.

Solitary or cespitose in open places or in thin woods. California. Mrs. C. A. Hunt.

Sometimes the pileus is a little darker on the incurved margin and its surface may be obscurely spotted.

Hygrophorus Davisii

Pileus convex, membranous, fragile, glabrous, very viscid, even on the margin when young, striate when mature, olive-brown variegated with olive-green when young and fresh; lamellae thin, unequal, distant, decurrent, grayish-white; stem slender, equal or slightly tapering upward, flexuous, fragile, hollow, viscid, glabrous, grayish-white, becoming brownish; spores broadly elliptic, white, 6–7 μ long, 4–5 μ broad.

Pileus 1–1.2 cm. broad; stem 2–3 cm. long, 1.5–2 mm. thick.

Damp places under ferns in deciduous woods. Stow, Massachusetts. August, 1905. S. Davis. Gregarious. In the dried specimens the whole plant has assumed a yellowish-buff color with a faint tinge of pink. The pileus is sometimes slightly centrally depressed. The species is dedicated to its discoverer.

Russula nigrescentipes

Pileus convex, nearly plane or centrally depressed, glabrous, striate on the margin, bright-red, flesh white, taste mild; lamellae narrowed and united behind, much broader in front, close, equal, free or nearly so, white; stem equal, glabrous, stuffed or spongy within, tough, elastic, white, becoming blackish by handling or bruising; spores globose or subglobose, white, 6–8 μ in diameter.

Pileus 3–5 cm. broad; stem 3–5 cm. long, 6–8 mm. thick.

In woods. Near St. Louis, Missouri. September. N. M. Glatfelter.

This species is related to *R. uncialis* Peck, from which it may be distinguished by its smaller spores and by its tough stem becoming black where bruised. The stem is sometimes slightly tinged with red at the base. The change of color in the stem is a peculiar feature by which the species may easily be recognized. It is suggestive of the specific name.

Russula subvelutina

Pileus firm, convex or slightly depressed in the center, dry, minutely pubescent or velvety tomentose, even on the margin, dark-red or crimson, sometimes a little darker in the center, cuticle adnate, flesh white, thick, taste sweet; lamellae moderately close, adnate, sometimes forked at the base, white, becoming creamy-yellow, the interspaces venose; stem equal or tapering downward, stuffed or spongy within, not polished, white tinged with red; spores nearly smooth, subglobose, pale-yellow, 7–10 μ broad.

Pileus 5–11 cm. broad; stem 5–10 cm. long, 10–15 mm. thick.

Near St. Louis, Missouri. August. This is one of our most beautiful red russulas. N. M. Glatfelter.

Externally it resembles *R. ochrophylla* Peck, from which it may be separated by its less glabrous pileus and its paler spores and lamellae.

Lentinus obconicus

Pileus obconic, fleshy, sometimes slightly depressed in the center, whitish, with tawny-brown squamules in the center, flesh white; lamellae narrow, close, very decurrent, lacerated and dentate on the edge; stem long, flexuous, solid, whitish at the top, tawny-brown and squamose toward the base; spores oblong, 8–10 μ long, 4–5 μ broad.

Pileus 2.5–6 cm. broad; stem 5–8 cm. long, 6–10 mm. thick.

Cespitose; decaying wood in a lumber yard. Minneapolis, Minnesota. M. S. Whetstone.

The thick flesh and obconic shape of the pileus with the long decurrent lamellae are the prominent distinguishing characters of this species. The flesh of the dried specimens cuts easily. The scales of the pileus are smaller than in *L. lepideus* Fr. It is closely related to *L. cyathiformis* (Schaeff.) Bres.

Lentinus microspermus

Pileus fleshy, thin, convex, somewhat irregular, sometimes lobed on the margin, glabrous, reddish-brown, flesh white, taste sweet, then bitter; lamellae thin, close, emarginate, adnexed, white, becoming creamy-yellow, the edge eroded or denticulate; stems cespitose, equal, glabrous, fleshy-fibrous, hollow, white or whitish, sometimes eccentric; spores minute, globose, white or faintly tinged with yellow, 3–4 μ broad.

Pileus 2.5–5 cm. broad; stem 5–6 cm. long, 6–10 mm. thick.

Decayed wood. Creve Coeur, Missouri. May. N. M. Glatfelter.

Annularia sphaerospora

Pileus fleshy but thin, conic or subcampanulate, becoming expanded, umbonate, silky-fibrillose, yellow, fading to whitish either wholly or in part, umbo brownish; lamellae thin, close, free, whitish or cream-colored when young, flesh-colored when mature; stem equal or slightly tapering upward, solid, fibrous, substriate, whitish, annulate, the white collar sometimes near the middle, sometimes near the base of the stem; spores globose or subglobose, 5–6 μ in diameter.

Pileus 3–6 cm. broad; stem 3–8 cm. long, 4–8 mm. thick.

Decaying wood of elm. Near Detroit, Michigan. August. O. E. Fischer.

The plants are sometimes cespitose. The species may be distinguished from its near relative, *A. Fenzlii* Schulz, by its umbonate fading pileus and its whitish solid stem. *A. Fenzlii* grows on *Tilia*. Twelve species of this genus are described in Sylloge, none of which is credited to this country.

Inocybe desquamans

Pileus convex, umbonate, subglabrous, yellowish-brown becoming brownish-red with age, or in drying, the umbo often darker, the cuticle cracking, forming scales and disappearing except on the umbo, flesh thin, white; lamellae pallid becoming ferruginous-brown; stem firm, solid, fibrous, striate, subbulbous, whitish and mealy above, reddish or brownish and slightly fibrillous below, becoming wholly brownish with age; spores irregular, nodulose, 8–10 μ long, 5–6 μ broad.

Pileus 2.5–4 cm. broad; stem 5–7.5 cm. long, 2–4 mm. thick.

Woods. Near St. Louis, Missouri. July. N. M. Glatfelter.

• Inocybe Sterlingii

Pileus fleshy, convex becoming nearly plane, glabrous and slightly viscid in the center when moist, obscurely fibrillose on the incurved subappendiculate margin, brownish in the center, gray or clay-colored elsewhere, taste farinaceous; lamellae thin, close, adnexed, pallid becoming cinnamon; stem equal or slightly thickened at the base, solid, floccose-fibrillose white, bay red within; spores even, elliptic, usually uninucleate, 10–12 μ long, 6–8 μ broad.

Pileus 1.5–2.5 cm. broad; stem 2.5–3.5 cm. long, 2–4 mm. thick. Under spruce trees. Trenton, New Jersey. November. E. B. Sterling.

This species is related to *I. vatricosa* Fr. from which it is separated by the darker color of the pileus, its solid stem, more fully developed veil and farinaceous taste. The veil is fibrillose or webby and adheres partly to the margin of the pileus and partly to the stem on which it forms a slight fibrillose, evanescent annulus. It is solitary or gregarious and is said by its discoverer, for whom it is named, to be edible.

• Flammula condensa

Pileus thin, convex or nearly plane, often irregular from its crowded mode of growth, usually umbonate, very viscid, brownish-yellow, the umbo reddish-brown or chestnut-colored, flesh white, often tinged with yellow; lamellae moderately broad, subdistant, adnate or slightly decurrent, sometimes rugosely wrinkled, yellowish becoming brownish-ferruginous; stem equal, hollow, yellowish above, pallid or brownish toward the base; spores elliptic, 8–10 μ long, 4–5 μ broad.

Pileus 2–3 cm. broad; stem 2–4 cm. long, 2–3.5 mm. thick. Densely cespitose. In clearings in pine woods and on stony hills. Near Washington, D. C. December. F. J. Braendle.

This species forms large flat-topped clusters of many individuals. It is closely related to *F. carbonaria* Fr. and *F. squalida* Peck, but it may easily be separated from both by its more dense mode of growth and its broader and more distant lamellae.

Psathyrella angusticeps

Pileus very thin, submembranous, conic or subcampanulate, subacute, often with a small but prominent umbo, hygrophanous,

fragile, minutely flocculose, appendiculate with minute fragments of the whitish veil, sometimes striate on the margin, grayish-brown, whitish or grayish on the margin; lamellae ascending, thin, brittle, moderately close, adnate, pale olive-green becoming darker and finally black; stem very long, slender, fibrous, rather tough, hollow, straight or nearly so, ashy-gray above, chestnut-colored below, sometimes slightly thicker toward the base; spores broadly elliptic, black, abruptly narrowed at the ends, 15–20 μ long, 10–12 μ broad.

Pileus 1–2 cm. broad; stem 5–9 cm. long, about 1 mm. thick.

Gregarious. Grassy ground. Falmouth, Massachusetts. June. S. Davis.

This species is ambiguous, combining the characters of *Panaeolus* and *Psathyrella*. Its spores are similar in size and shape to those of some species of *Panaeolus*, but the tendency of the pileus to become striate on the margin, which is apparently straight and does not extend beyond the lamellae, and the uniform color of the latter, indicate that its proper place is in *Psathyrella*.

Hydnum Blackfordae

Pileus fleshy, convex, glabrous, grayish or greenish-gray, flesh whitish with reddish stains, slowly becoming darker on exposure; aculei subulate, 2–5 mm. long, yellowish-gray becoming brown with age or in drying; stem equal or slightly tapering downward, solid or stuffed, becoming hollow in drying, glabrous, colored like the pileus; spores brown, subglobose, verrucose, 8–10 μ broad.

Pileus 2.5–6 cm. broad; stem 2.5–4 cm. long, 3–4 mm. thick.

Mossy ground in low springy places in damp mixed woods. Ellis, Massachusetts. August, 1904. Mrs. E. B. Blackford.

This species is peculiar in its colors and in its rather long stem. Sometimes there is a slight pinkish tint visible on the pileus. In the dried specimens blackish hues have been assumed, especially by the stems. The species is dedicated to its discoverer. It is apparently very rare.

Craterellus Pogonati

Pileus membranaceous, sessile or stipitate, irregular, 2–4 mm. broad, minutely tomentulose, white; hymenium even, pale creamy-yellow; stem when present lateral or eccentric, slender, tomentulose or sometimes glabrous on one side by reason of the decurrent hymenium, white.

On moss, *Pogonatum alpinum* Roehl. South Windsor, Connecticut, September, 1904. C. C. Hanmer. The specimens are sterile, but the species may be recognized by the described characters. The dimensions here given are those of the dried specimens and may be a little less than those of fresh plants.

Monilia Avenae

Minute, amphigenous; hyphae short, about 8 μ thick, effused on oblong or subelliptic, indefinite, pallid or brownish spots, grayish or grayish-brown; spores cat nulate, oblong or elliptic, slightly colored, 25–40 μ long, 12–15 broad.

Living or languishing leaves of some unidentified species of *Avena*. Near Los Gatos, California. February, 1904. A. A. Heller. "The wild oat plants here are often badly infested by this fungus and the young plants on which it appears have their growth checked and they seem never to reach maturity." — A. A. H.

Marsonia Potentillae Helleri var. nov.

Spots small, inconspicuous, angular, pallid; acervuli unequal, irregular, single or sometimes two or three on a spot, black; spores oblong, 20–24 μ long, about 4 μ broad, the upper cell abruptly narrowed into an oblique beak, both cells destitute of guttulae.

Living leaves of *Drymocallis glandulosa* (Lindl.) Rydb. Near Los Gatos, California. May, 1904. A. A. Heller. The paler inconspicuous spots of the leaves, darker-colored acervuli, and more narrow spores without oil globules distinguish this variety from the species.

Haplosporella commixta

Perithecia single or clustered, numerous, thin, globose, erumpent, black; spores broadly elliptic or obovate, colorless when young, becoming dark-brown (by transmitted light) when mature, 24–32 μ long, 16–20 μ broad.

Bark of dead branches of slippery elm, *Ulmus fulva* Michx. Stockton, Kansas. January, 1905. E. Bartholomew.

The specific name is suggested by the commingling of pustules containing a single perithecium with others containing two or more. This feature of the species shows the intimate relation between the genera *Sphaeropsis* and *Haplosporella*, and the species may be considered a connecting link between the two genera.

Sarcoscypha dawsonensis

Receptacle cupular, 1–2 cm. broad, crowded or cespitose, sessile or radicated, often uneven or sulcate at the base, irregular, externally pruinose or tomentulose, pallid, whitish at the base; hymenium red or orange, often rugosely wrinkled; asci cylindric, 200–280 μ long; spores monostichous, elliptic, even, 20 μ long, 10 μ broad, paraphyses slender, filiform, slightly thicker at the top.

Among mosses, *Leptobryum pyriforme* Schimp. West Dawson, Yukon Territory. July, 1905. E. B. Sterling communicated it.

The minute tomentum of the exterior surface of the cups is composed of slender colorless septate filaments. The hymenium of the dried specimens is pruinose.

Poronia macrospora

Stroma 0.75–1.5 cm. broad, irregular, broadly ovate or depressed-globose, stipitate, punctate by the slightly prominent black or blackish ostiola, reddish-brown or blackish-brown, white within; stem irregular, flexuous, slender, simple or with one or two short branches at the top, sometimes enlarged at the apex, crispate tuberculate and perforate at the base, blackish-brown, white within; perithecia immersed in the stroma, black, the ostiola usually surrounded by a pale band; spores very large, elliptic, at first colorless and involved in mucus, then colored, 40–60 μ long, 20–30 μ broad.

Rich sandy ground in a garden. New Haven, Connecticut, December, 1905. P. W. Graff.

This species is remarkable for the large size of the spores, which character has suggested the specific name. The stem is deeply set in the ground and the lower or subterranean part is enlarged, twisted, irregular and uneven or crumpled. The top expands into the stroma which is not disciform in our specimens.

Leptosphaeria Lythri

Perithecia minute, scattered, depressed, partly covered by the scurfy remains of the epidermis, black, usually with a minute papilliform ostiolum; asci oblong or clavate, 100–150 μ long, 20–30 μ broad, the base very short; spores oblong or subfusiform, straight or slightly curved, colorless becoming yellowish-brown with age if viewed with transmitted light, 5–7-septate, the third cell usually larger than the others, 30–40 μ long, 12–16 μ broad.

Dead stems of the wing-angled loosestrife, *Lythrum alatum* Pursh. Stockton, Kansas. October. Common. E. Bartholomew.

Pleospora magnifica

Perithecia minute, at first covered by the thin epidermis, then erumpent or subsuperficial, hemispheric or depressed-globose, black, the ostiolum minute, inconspicuous; asci oblong, cylindric, 200–240 μ long, 48–60 μ broad; spores large, colored, crowded or biseriate, oblong or slightly narrowed toward one end, obtuse, 7–9-septate with about 3 longitudinal septa, 65–75 μ long, 25–35 μ broad.

Dead stems of *Phlox*. Silver Lake, Utah. August, 1905. A. O. Garrett collected it. E. Bartholomew communicated it. Remarkable for the large size of the muriculate spores.

GEOLOGICAL HALL, ALBANY, NEW YORK.

The anomalous anther-structure of Dicorynia, Duparquetia, and Strumpfia

James Arthur Harris

While engaged in the histological portions of a study of the apically dehiscent anther,* I found myself particularly interested by three forms which have not been fully understood by systematists, and since it will probably be a considerable time before my final memoir can appear it has seemed advisable to offer my notes on these genera in a form and place which will render them more accessible to the taxonomist, for whom they are particularly intended, than they would be in a thick paper of morphological and ecological nature. The forms to be considered here are *Dicorynia* and *Duparquetia* of the *Leguminosae*, and *Strumpfia* of the *Rubiaceae*.

We may confine our attention strictly to the morphological features, leaving histological detail for the special treatment.

The first form is *Dicorynia* Benth.† The androecium of this peculiar South American representative of the *Cassieae* has been characterized as follows: Stamens 2, free, unequal; filaments short and thick; anthers basifixed, oblong, short and thick, that of the shorter stamen longer, often 8-locellate, dehiscing at the apex.

The form of the anthers in the specimen examined agrees very closely indeed with that figured in Flora Brasiliensis. Both anthers are smooth, brown in color and very hard. A series of sections was secured and mounted in sequence. Figures 1, a and 1, b represent sections from near the base and tip of the smaller anther, the one borne on the longer filament, and show that it has the 4-locellate structure of a typical anther.

In systematic works the larger anther, borne on the shorter filament, has been described as 8-locellate, and the first prepara-

* See Harris, J. A. Ann. Rep. Missouri Bot. Gard. **16**: 167–257 (1905), and Canadian Entomologist **37**: 353–357, 373–380, 393–398 (1905).

† Benth.; Mart. Fl. Bras. **15**²: 81. *pl.* 29.—Benth. & Hook. Gen. Pl. **1**: 571.—Taubert; E. & P. Nat. Pfl. **3**³: 165.

tions examined confirmed this opinion. Later, however, when serially arranged sections were secured, the real condition became apparent and is made quite clear by the outline drawings of selected sections for the series. Figures 1, c, 1, d and 1, e represent typical planes of the anther from the base to near the tip. It will be seen that all show two locules. In the lowermost sections each locule evidences two locelli. The succeeding sections show six, eight, and near the tip even ten locelli.

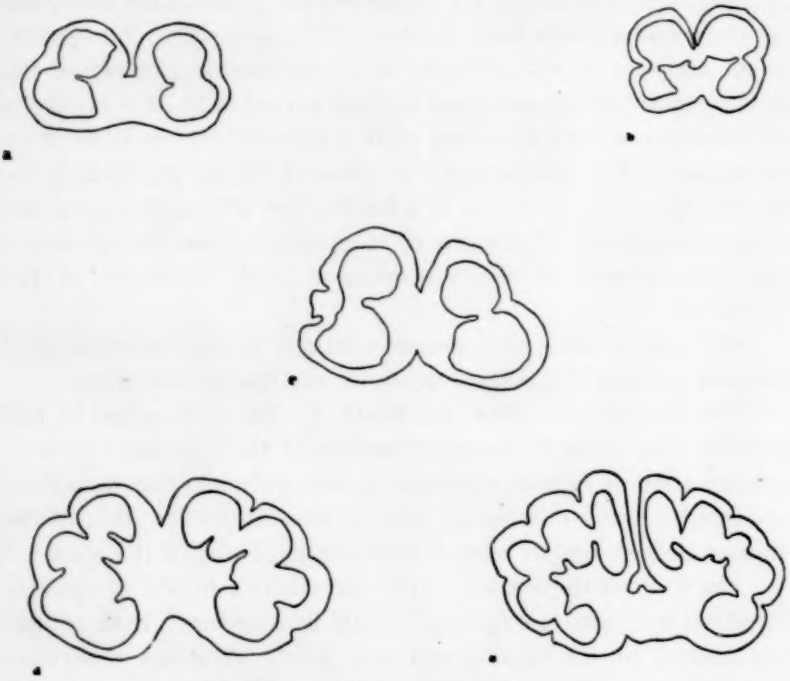

FIGURE 1. Anther-structure of *Dicorynia*.

In structure and geographical distribution *Duparquetia* Baill.* is an anomalous and most interesting monotypic genus found in west tropical Africa.

The androecium has been described as follows: Stamens 5, more rarely 4; filaments short, flattened; anthers basifixed, linear,

* Baillon, Adansonia **6**: 189. *pl. 4.* — Benth. & Hook. Gen. Pl. **1**: 570.— Benth. Trans. Linn. Soc. **25**: 305. *pl. 39.* — Bois, Jour. de Bot. **17**: 16–22. *f.* 1–18.—Taubert; E. & P. Nat. Pfl. 3^3: 166.

slightly sagittate at the base and bifid at the apex, with the locules acuminate, longitudinally sulcate and dehiscing above by short slits not extending more than half the length of the locules; three upper stamens longitudinally connate, 1 or 2 lateral free, or all more or less firmly coherent at time of flowering, all strongly decurved over the ovary.

I have examined this form and find that dehiscence is as described. The anthers in my specimen were four, on very short, free filaments. In the dry condition they were hard, with the introrse terminal slit widely open but not extending more than a third the length of the conspicuous longitudinal furrow. When moist the walls were leathery in texture. In this condition they may easily be ruptured along the furrow, but the wall is firm enough here to indicate that in nature dehiscence is probably confined exclusively to the short terminal slits.

As will be seen from the literature some confusion has prevailed concerning the androecium of this species. Baillon considered that there are eight apiculate, laterally coherent unilocular anthers. Other writers have correctly regarded the androecium as composed of four or five laterally coherent bilocular anthers, with each locule produced into a terminal apiculum. This interpretation has been corroborated, with the addition of very interesting structural points, by the study of serial sections.

The members of the androecium are slightly coherent, but so far as could be determined there is no organic connection.

The structure of the anther is most intelligible when the sections are followed from the base towards the tip. As will be seen from figures representing the gross structure of the flower, the individual anthers are borne on short, flattened filaments extending as a ventral dark-brown connective towards the tip of the anther. The lowermost sections show only this connective (figure 2, a). A little above this plane the locules will be seen, the walls originating from the ventral surface of the connective (or filament) towards the median line (figure 2, b), the two margins of the connective extending as lateral wings. A little further above, the sections show a normal introrse anther with a prominent connective and two locules. The locellus-walls are broken down but evidently have been very short and the original division into four

locelli secured by the strong invagination of the lateral wall which is folded in almost to the connective. Here there is an indication of a beginning of the separation of the two locules (figure 2, c). The split soon extends across the connective, leaving the two halves of the anther free for the greater portion of their length. These conclusions are drawn from the examination of sections, and it is quite probable that the two halves become disconnected

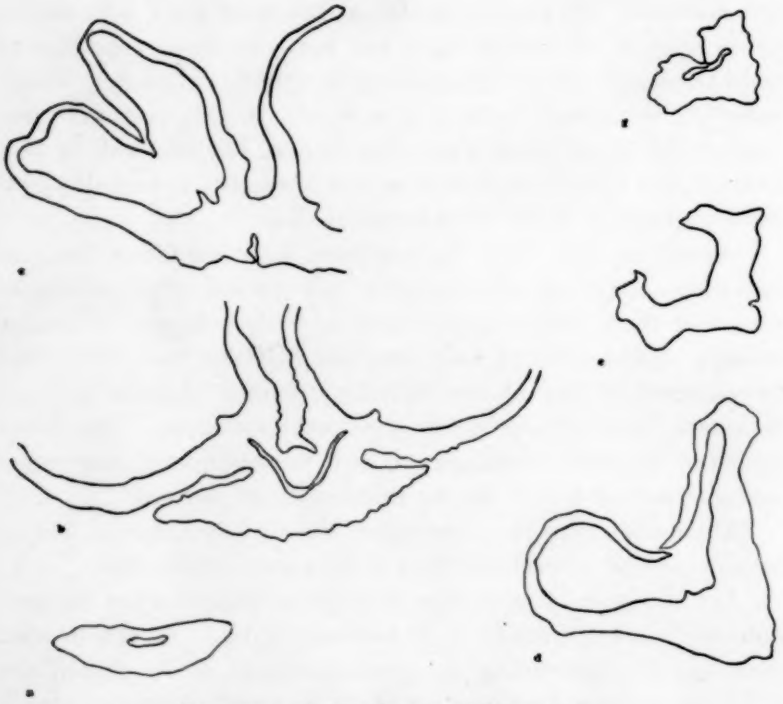

FIGURE 2. Anther-structure of *Duparquetia*.

lower in the anther in the process of sectioning than they would otherwise. At the same time the sharpness with which they are divided along the median line and the distance to which this separation of the locules extends from the tip indicate a natural longitudinal division.

As has been stated in the description of the gross structure of the flower, each locule opens by an introrse longitudinal split extending for some distance from the tip. The exact form of this

is made very clear by the sections. In the lower portion of each locule the wall is invaginated so as to be brought almost in contact with the connective, to which it has evidently been joined by a very short locellus-wall, the vestiges of which may still be seen extending from the connective and from the invaginated margin of the wall (figure 2, c). A little above this plane the furrow is not so deep and sharp but more rounded and the vestiges of the locellus-wall have almost completely disappeared. The wall then breaks along the line of invagination and throughout the remainder

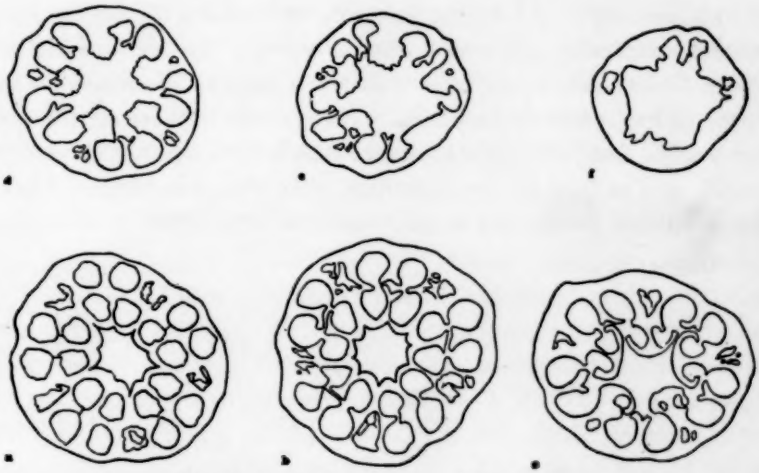

FIGURE 3. Anther-structure of *Strumpfia*.

of the length the margins gape more widely until the thickened, sterile tip is reached.

The third genus, a member of the *Rubiaceae*, is *Strumpfia* Jacq.* This genus is represented by a single species on the rocky coasts of the Antilles.

The androecium has been described as follows: "Anthers subsessile, wholly connate, nearly free from the corolla-base, forming an ovate-oblong column, membranaceous at the top, a little exceeded in length by the corolla segments" (Grisebach). DeCandolle says: "Antheris in tubum ovoideo-oblongum subpenta-

* Benth. & Hook. Gen. Pl. 2: 117. — DC. Prod. 4: 469. — Griseb. Fl. Brit. W. Ind. 335. — Jacq. Stirp. Am. 218. — Lam. Illustr. *pl.* 731. — Schnizlein, Iconog. *pl.* 127*b*. — Schumann; E. & P. Nat. Pfl. 4[4]: 104.

gonum concretis intus 5-locularibus, loculis nempe 3 externis, 2 internis regulariter dispositis!" but Grisebach writes: "The anomalous structure of the column, described by DeCandolle, must have been a monstrosity; for I find 10 anther-cells, regularly arranged in a single row." The figure given by Schnizlein represents a condition such as DeCandolle describes. Schumann says of the androecium: "Stb. unter sich der ganze Länge nach zu einer dem Grunde der Blkr. angehefteten Röhre verbunden; A. nur in der oberen Hälfte, wie mit Poren geöffnet."

Serial sections represented by figure 3 show the real condition of this synandrium. At the tips only the outer wall may be seen, smooth externally and rough internally. As the sections are followed down towards the base the cone is seen to be formed by the fusion of five 4-locellate anthers. Between these there are towards the outside four intercellular spaces which have been mistaken for locelli, and so lead to the statement that the synandrium has in the outer row fifteen and in the inner row ten locelli.

MISSOURI BOTANICAL GARDEN.

Some new or otherwise noteworthy plants from the coastal plain of Georgia

ROLAND M. HARPER

In five seasons of botanical exploration in the coastal plain of Georgia I have accumulated a few plants of special interest which were not sufficiently studied in time to be mentioned in the separate reports for each season which have already been published.* All but two of those mentioned below are to be included in a flora of the Altamaha Grit region which is now in press, and it seems desirable to discuss them here in advance, so that they will not require a disproportionate amount of space in the flora.

LYCOPODIUM PINNATUM (Chapm.) Lloyd & Underw. Bull. Torrey Club **27**: 155. 1900

The name of this pine-barren plant is antedated by *L. pinnatum* Lam. (Encyc. **3**: 654. 1789), said by its author to grow on trees in the West Indies. This species was mentioned by Beauvois (Prodr. Aetheog. 110) in 1805, Swartz (Syn. Fil. 186) in 1806, and Poiret (Encyc. Suppl. **3**: 541) in 1813, but seems to have been overlooked or ignored by later authors. There is no possibility of its being identical with our plant of the pine-barrens, so the latter should be re-named; I therefore propose to call it **Lycopodium prostratum,** in allusion to one of the characters by which it differs conspicuously from its nearest relative, *L. alopecuroides.*

Sporobolus teretifolius sp. nov.

Culms tufted, wiry, 7–8 dm. tall, erect or nearly so: leaves wiry, flexuous, ascending or recurved, about half as long as the culms, less than 1 mm. wide, oval in cross-section, compressed laterally, grooved on the ventral side:† panicles about half the

* Bull. Torrey Club **28**: 454–484. *pl. 29;* **30**: 282–295, 319–342. *f. 1–3;* **31**: 9–27. *f. 1–4;* **32**: 141–171. *f. 1–5;* **32**: 451–467. *f. 1–5.*

† The following notes on the internal structure of this peculiar leaf may be of interest. The dorsal surface completely surrounds the leaf, and is remarkably smooth, without perceptible furrows or trichomes. The ventral surface is confined to the very

length of the culms, diffusely branched: spikelets yellowish, 3–4 mm. long, solitary on capillary diverging pedicels 5–15 mm. long: scales acute, the outermost one half to two thirds as long as the rest.

A very distinct species, related to *S. Curtissii* (Vasey) Small and *S. floridanus* Chapm. *S. Curtissii* has stiffer and broader leaves of very different structure,* and its spikelets are chestnut-colored, mostly appressed to the nearly straight ascending branches of the subsimple panicle, and longer, with the scales more attenuate and the outermost nearly as long as the rest. The inflorescence of *S. floridanus* is more like that of the new species, except that the spikelets are purplish and more numerous, but the whole plant is much stouter, and the leaves are nearly flat and often 5 mm. broad.†

Sporobolus teretifolius is a frequent and characteristic inhabitant of moist pine-barrens in the Altamaha Grit region,‡ flowering from July to September. I have collected it in Coffee County near Douglas, September 22, 1900 (*no. 677*), and in Colquitt County

FIGURE 1. Cross-section (somewhat schematic) of leaf of *Sporobolus teretifolius*, enlarged about 20 diameters.

narrow groove, the depth of which at the middle of the leaf is about two fifths of the longest diameter of the leaf. In this groove are a few very short conical hairs. Stomata occur on both surfaces, but are most noticeable in the groove. The leaf figured herewith (taken from an undistributed specimen of my *no. 1642*) contained thirteen vascular (mestome) bundles, of various sizes, as indicated in the figure. The central portion is filled with large-celled colorless parenchyma, without perceptible intercellular spaces. Between the vascular bundles and the epidermis the cells (stereome) are very dense and thick-walled, their cavities being scarcely perceptible. The chlorophyl seems to be confined to the peripheral cells of the bundles.

* In *Sporobolus Curtissii* the leaf is about 2 mm. wide when flat, but usually becomes conduplicate when dry. There is a well-marked groove on either side of the midrib, both above and below, and in the ventral grooves can be seen the bulliform cells by means of which the opening and closing of the leaf is accomplished. There are nine mestome bundles, four on each side of the midrib.

† See Bull. Torrey Club **28**: 464, 465. 1901.

The ranges and habitats of these three species will be contrasted in my forthcoming flora. Morphologically the distinction between them and certain species of *Muhlenbergia* (belonging to the section *Trichochloa* of many authors, or genus *Podosemum* of Desvaux) is a rather subtle one. In aspect as well as in habitat and distribution the diffuse-panicled species of *Sporobolus* and *Muhlenbergia* seem more closely related to each other than to the original species of either genus.

‡ See Torreya **5**: 114. 1905.

near Moultrie, September 20, 1902 (*no. 1642*). (In the herbarium of the New York Botanical Garden *no. 677* happens to be the best specimen, but I will designate *no. 1642* as the type because I have distributed more specimens of it, and still have some left.) It is unmistakable when seen in the field, and I have also noted it in similar situations in the counties of Dodge, Irwin, Berrien and Dooly. A specimen in the Columbia University herbarium collected by Prof. S. M. Tracy in the vicinity of Irby P. O. (Cycloneta sta.), in Irwin County, July 28, 1890 (distributed as *Muhlenbergia trichopodes*) is evidently the same thing. No stations for it outside of the Altamaha Grit region are yet known.

SPARTINA BAKERI Merrill, Bull. Bureau Plant Industry U. S. Dept. Agr. **9**: 14. 1902

In a recent paper * I described an unidentified *Spartina* (*no. 2187*) collected near Brunswick in May, 1904, and referred it doubtfully to *S. juncifórmis*. A few days later I came across the original description of *S. Bakeri* (a species which I had overlooked before because it was not represented in the herbaria in New York nor mentioned in Dr. Small's flora), and recognized it at once as belonging to my plant. Prof. A. S. Hitchcock has since kindly compared one of my specimens with the type in the U. S. National Herbarium and pronounces them identical. *Spartina Bakeri* was based on a specimen from Orange County, Florida, and was reported at the same time from several other stations in the eastern and central parts of that state; but my station seems to be the first outside of Florida.

RHYNCHOSPORA LEPTORHYNCHA [Wright?] Sauv. An. Acad. Cienc. Habana **8**: 84. 1871

Originally described from Cuba ("*En lagunas de poca profundidad, en los pinales de la Vuelta de Abajo*"), this species, or something very near it, has turned up in pine-barren ponds in Georgia. I have specimens from Sumter (*no. 467*, August 23, 1900) and Pulaski (*no. 1377*, June 26, 1902) counties in the Lower Oligocene region, and have noted it about three miles south of Douglas in the Altamaha Grit region. All my specimens have

* Bull. Torrey Club **32**: 458. 1905.

the stem stiffly curved through an arc of 45°–60° between the uppermost cluster of spikelets and the next one below it, a character which does not appear in the type-specimens (Wright's *no. 3784*). Furthermore, it is very unusual for a species growing in the pine-barren ponds of Georgia to be identical with one in the West Indies; but the structural difference above mentioned can hardly be considered as of specific value by itself.

JUNCUS BIFLORUS Ell. Bot. S. C. & Ga. **1**: 407. 1817

J. marginatus biflorus Chapm. Fl. So. U. S. 495. 1860.

J. marginatus pinetorum Nash, Bull. Torrey Club **22**: 145. 1895; Heller, Cat. N. Am. Pl. 31. 1898; Hitchcock, Trans. Kans. Acad. Sci. **17**: 82. 1901. (Name only.)

J. aristulatus pinetorum Coville; Small, Fl. S. E. U. S. 259. 1903.

The first locality mentioned by Elliott for his *Juncus biflorus* is "10 miles from Savannah, on the road to Augusta." With a view of settling the identity of this species I went to the spot indicated on June 18, 1903, and found it to be right in the village of Monteith, Chatham County. I soon saw a plant answering the description, but as its habitat there had been too much damaged by civilization, I went about a mile away before collecting any of it. My *no. 1842*, from the vicinity of the nearby station of Meinhard, may reasonably be considered typical. It is essentially the same as a plant which is common in the pine-barrens of Georgia and some adjoining states, and differing from its nearest relatives, *J. marginatus* and *J. aristulatus*, by the characters pointed out by Dr. Chapman and Mr. Coville. It is so frequent in Georgia that I will cite only the stations where I have collected it, which are in the following counties: Sumter (*478*, *483*), Screven (*784*, *788*, both from that part of the county which has just been put into the new county of Jenkins), Bulloch (*868*, an excellent specimen), Washington (*1328*), Laurens (*1373*), Charlton (*1495*), Chatham (*1842*), and Bryan (*1846*). Unlike its nearest relatives, it is strictly confined to the coastal plain, and grows usually in moist pine-barrens, but sometimes even in dry pine-barrens or on sand-hills. It is said to range from North Carolina to Florida, and it will doubtless hereafter be found farther west. In Georgia it flowers in May and June.

Juncus scirpoides compositus var. nov.

Rootstocks, stems and leaves essentially similar to those of *J. scirpoides* Lam. (as that species is commonly interpreted). Flowers in short dense spikes, which are aggregated to the number of about half a dozen in each of the numerous subglobose heads about 8 mm. in diameter: sepals acute, 2 mm. long: capsules beaked, about 2.5 mm. long,

The form here proposed as a new variety has been collected by several botanists, but hitherto always included in *J. scirpoides*. It was briefly described by Chapman (Fl. So. U. S. 494) in 1860, and a few years later by Engelmann (Trans. Acad. Sci. St. Louis **2**: 468, 469. 1868), who placed it as a form of his *J. scirpoides macrostemon macrostylus*, but without giving it a name. *J. scirpoides* normally has heads spherical and not perceptibly lobed, sepals 3 mm. and capsule often 5 mm. long. I have never had any difficulty in recognizing the new variety in the field, even from dead specimens nearly a year old; and in the herbarium it is as easily distinguished from *J. scirpoides* as are *J. megacephalus*, *J. brachycarpus*, and perhaps others. In view of its distinctness (which may some time perhaps entitle it to specific rank) there can be no object in letting it remain longer unnamed.

My specimens are from a shallow pond in the sand-hills of the Satilla River near the center of Coffee County, July 25, 1902 (*no. 1445*). I have seen the same thing in the counties of Dodge and Berrien, which are likewise in the Altamaha Grit region, and McIntosh, Wayne and Charlton in the flat pine-barren country, usually around sand-hill ponds and bogs. Its habitat is distinctive, and usually not shared by any other *Juncus*. It seems to flower mostly in July.

I have examined the following specimens besides my own:

SOUTH CAROLINA: "Damp margin of an old millpond, Aiken, with *Juncus dichotomus*, etc.," July 2 and 28, 1868, H. W. Ravenel (Engelm. Herb. Junc. Bor. Am. Norm. *no. 67*).

FLORIDA: Low grounds near Jacksonville, September, A. H. Curtiss (*no. 2981**). Near Jacksonville, July 19, 1893, A. H. Curtiss (*no. 4152*). Moist ground near Jacksonville, Sept. 1, 1894, A. H. Curtiss (*no. 5176*). Sandy swamps, Apalachicola, 1896, Chapman (Biltmore Herb. *no. 4082a*). Low pine land near Eustis, June 9, 1894, G. V. Nash (*no. 917*). Tampa, Britton & Wilson,

Aug. 25, 1903 (*nos. 30, 63*). Hammocks, Ft. Lauderdale, Nov. 19 or 25, 1903, Small & Carter (*no. 1139*).

MISSISSIPPI: Cat Island, Aug. 28, 1900, Lloyd & Tracy (*no. 364*).

It would have been appropriate to make the specimen distributed by Engelmann the type, but as it apparently did not come from a natural habitat, I will designate my own instead.

POLYGONELLA GRACILIS var. ?

On the sand-hills of Seventeen Mile Creek in Coffee County I collected in September, 1903, some specimens of a curious *Polygonella* (*no. 2010*) with linear acute leaves 5 to 8 cm. long, but otherwise indistinguishable from *P. gracilis* (Nutt.) Meisn., which normally has cuneate-obovate leaves 2 to 4 cm. long. The typical form was not observed in the vicinity, and I have never even seen it in the same county. Whether my plant should be called a new species, variety or form cannot be determined without further study, so I will leave it unnamed for the present.

Nymphaea fluviatilis sp. nov.

Rootstocks horizontal, about 3 cm. in diameter, the leaf-scars rather remote: leaves of two kinds, submersed and floating, both kinds glabrous throughout or essentially so; floating leaves with blades 12–25 cm. long by 10–20 cm. broad, their sinuses narrow or closed and about one third the length of the blades; petioles terete, about 5 mm. in diameter and often 2.5 meters long; submersed leaves about half the dimensions of the floating ones, with petioles not over 3 dm. long, and blades nearly as broad as long, very thin and crisped: peduncles similar to the petioles: flowers about 3 cm. in diameter: fruit green.

Nymphaea fluviatilis seems to be quite common in creeks, small rivers, and the swamps of large rivers, but apparently never in ponds, in the coastal plain. I have seen it in the Savannah River swamp in the southeastern corner of Effingham County, in Rocky Comfort Creek near Louisville, in Buckhead Creek near Millen, in the Ogeechee River near Chalker, Millen, Rocky Ford, Dover, and Meldrim, in the Canoochee at the type-locality (mentioned below), in the Ohoopee near Ohoopee and Reidsville, in the swamps of the Altamaha near Doctortown and Barrington, in the Oconee

swamps near Mount Vernon, in the Little Ocmulgee near Lumber City, in Echeconnee Creek near its mouth (on the line between Bibb and Houston counties), in the Ocmulgee River swamps near Abbeville, in the Withlacoochee near Nashville, and in the Flint River swamps in Crawford County near Everett; nineteen stations in all.

My specimens were collected on the morning of June 22, 1903, in sloughs of the Canoochee River near Groveland, in the northwestern corner of Bryan County. The river was rather low at the time,* and many of the floating leaves were left hanging high and dry in the nearby bushes by the receding water, presenting a rather unusual appearance (see FIGURE 2).

FIGURE 2. *Nymphaea fluviatilis* at the type-locality, photographed at time of collection. Note the very long petioles suspended above the water.

Nymphaea fluviatilis seems nearest related to *N. macrophylla* Small, a species said to range from Florida to Louisiana, from which it differs principally in its much slenderer rootstocks, longer and slenderer petioles, smaller leaf-blades with narrower sinuses, and smaller flowers. Accounts of different collectors differ as to whether the leaves of *N. macrophylla* are floating or emersed, but it is certainly not known to have any submersed leaves. It is almost superfluous to compare *N. fluviatilis* with the other southeastern species; but it differs from *N. advena* in having its princi-

* See U. S. Geol. Surv. Water Supply & Irrigation paper no. 98, pages 72 and 73, where some hydrographic measurements taken near the same place on the following day are given.

pal leaves floating, never erect, from *N. variegata* * in its terete petioles, from *N. sagittifolia* in the shape of its leaf-blades, and from *N. orbiculata* in habitat, smaller size of all its parts, and absence of silvery pubescence on the submerged portions.

The new species is undoubtedly the commonest representative of the genus in South Georgia, where only two other species are known, namely, *N. orbiculata* in some of the large ponds in the southern tier of counties, and an apparently undescribed species with red-bordered fruit in Long Pond, Lowndes County.† In Middle and Northwest Georgia I have seen only *N. advena*, and that only two or three times.

This genus presents a very interesting problem in geographical distribution. In eastern North America the species with floating leaves seem to be confined to the glaciated region and coastal plain, and the only one known in the Metamorphic and Palaeozoic regions is *N. advena*, with erect leaves.‡ This is of course largely due to the scarcity of permanent ponds in the older regions, but just why there should be no floating-leaved species in the streams of these regions is not clear.

Sarracenia minor × psittacina

In September, 1902, I found in moist pine-barrens near Okapilco Creek, in the center of Colquitt County, several specimens of an unfamiliar *Sarracenia* which appeared exactly intermediate between *S. minor* Walt. and *S. psittacina* Michx., both of which were growing not far away. It was not abundant enough to collect, however, and some attempts to photograph it turned out badly. So in August, 1903, I revisited the spot, only to find the creek swollen by recent rains, the desired specimens all under water, and collecting out of question.

No further light on the subject was received until May 16, 1904, when I was agreeably surprised to find the same thing in Douglas, within a few feet of the specimens of *S. flava* × *minor*

* See Miller, Proc. Biol. Soc. Wash. **15**: 11–13. *f. 1. pl. 2.* 1902.

† See Bull. Torrey Club **31**: 15. 1904.

‡ See in this connection Mr. Miller's paper just cited, also Rhodora **7**: 69–80. 1905. Mr. Miller noted a marked difference in the ranges of the two plants he was discussing, and attempted to correlate them with temperature zones.

figured in a recent number of the BULLETIN.* Here again it was accompanied by the two species suspected of being its parents, as well as by *S. flava*. There were only a few specimens of the new hybrid, but being now convinced that I could find it elsewhere, I did not take any of them, but determined to look for it around Fitzgerald, in Irwin County, where I was going the same evening. On the morning of my departure from Fitzgerald, the 18th, my search was rewarded by finding about a dozen specimens of the hybrid about a mile east of the city, in company with the two parents, as usual. The specimens collected at that time, five in number, are numbered *2211*. On the afternoon of the same day I saw the same thing, with its parents, about five miles southeast of Rochelle, in Wilcox County.

There can be no reasonable doubt as to the hybrid origin of this plant, and I will not attempt to characterize it, for words are almost inadequate for describing such curiously shaped organs as the leaves of *Sarracenia*,† particularly those of this hybrid. If the reader can imagine a plant exactly intermediate in appearance between *S. minor* and *S. psittacina* he will have a fair idea of the form in question.

An artificial hybrid between the same two species is called *S. formosa*, and the figure of it in Nicholson's Dictionary of Gardening (**3**: 365. *f. 419*) resembles my plant very closely.

Unlike *S. flava* × *minor*, the new hybrid seems to be fertile, for I have seen several specimens bearing old capsules. I have no information as to the color of its flowers, however.

AMELANCHIER sp.

On June 6, 1901, I collected in a sandy bog near Graymont, Emanuel County, some fruiting specimens of an *Amelanchier* (*no. 819*) which seems to differ from all described species. It is a shrub with horizontal subterranean stems, sending up slender

* **32**: 462. *f. 4*. 1905. At this particular spot, which I have often visited, there are within an area not over 50 feet square about 50 species of moist pine-barren plants, including such things as *Taxodium imbricarium*, *Sporobolus teretifolius*, *Eriocaulon lineare* and *Baldwinia atropurpurea*, which are of particular interest to me for obvious reasons.

† It is probably for this reason more than any other that some of the most distinct species of this genus were confused by botanists of the first half of the 19th century.

erect flowering stems 4–6 dm. tall, bearing several short ascending sparingly pubescent branches above the middle. The leaf-blades are oblong, 1.5–4 cm. long and 1–2 cm. broad (the largest on young shoots), subacute at the apex, finely serrate nearly to the truncate or cuneate base, on petioles 6–10 mm. long. The upper surfaces are bright-green and shining, and reticulated with whitish veins, and the lower paler and minutely pubescent. The racemes are terminal, about 5 cm. long, 1 to 3 on each upright stem, few-flowered. Pedicels 6–12 mm. long, bearing 1 or 2 minute glands or tubercles near the middle. Petals unknown. Stamens numerous. Calyx-segments triangular, acute, 2 mm. long in fruit. Fruit globose, 5–7 mm. in diameter, purplish and glaucous.

The plant had very much the aspect of a small form of *Gaylussacia frondosa*, which grew with it. It seems to differ from all other southeastern species in its diminutive stature, shining leaves, and especially in habitat; but I do not care to name it without knowing more of its characters. On March 27, 1904, Mr. A. Cuthbert showed me some flowering specimens of what is probably the same thing in a similar habitat near Augusta, but I did not take any of them. If other botanists will look for this plant in the coastal plain of Georgia and the Carolinas we may soon know more about it.

RHEXIA ALIFANUS Walt. Fl. Car. 130. 1788

I can discover no good reason why this name should not supersede *R. glabella* Michx. Fl. Bor. Am. 1: 222. 1803. Walter's description is characteristic enough, and the two plants were recognized as identical or nearly so by Michaux himself, also by Poiret, Persoon, Pursh, Elliott, Torrey & Gray and Watson. Even if varietally or specifically distinct, Walter's name would still be entitled to recognition, for it is not known to be a synonym or homonym of any earlier species.

PROSPERPINACA sp.

In moist pine-barrens and branch-swamps in the Altamaha Grit region I have several times encountered a *Proserpinaca* which seems just intermediate between the two well-known species, *P.*

palustris and *P. pectinata*. In stature, diameter of stem, and length of leaves it is like *P. pectinata*, but the leaves, except some of the lowest, are not pinnatifid but merely toothed, a little more deeply than in *P. palustris*, however. It is too near Dr. Small's recently described *P. platycarpa** from South Florida to be described as a new species, and before it could be described as a new variety one would have to decide which of three species it should be appended to.

I have collected this problematic plant in the counties of Coffee (*no. 1427*) and Irwin (*no. 2210*), and have seen it in two or three other counties. *P. palustris* and *P. pectinata* both occur in the same region, but I have never seen them together, or either of them with the intermediate form; so the latter cannot be regarded as a hybrid.

? AZALEA ARBORESCENS Pursh

On the morning of July 21, 1903, I collected in rich damp woods at two stations in Randolph County a little north of Cuthbert a handsome *Azalea* with bright scarlet corollas (*nos. 1894, 1897*). Two days later I saw the same thing in similar situations near Fort Gaines, and the following week Dr. Eugene A. Smith found it in Barbour County, Alabama, a few miles farther west, and asked me to identify it. The late Rev. C. H. Hyde afterward informed me that he had known the plant in the vicinity of Cuthbert for years, but had never been able to place it correctly. An examination of specimens and literature after my return from the field showed it to be nearest related to *A. arborescens*, an Alleghanian species, from which it differs in its smaller size (being only a shrub), the midrib of the leaves appressed-strigose beneath, scarlet corollas, smaller calyx, and entire absence of glandular pubescence among the flowers. It does not seem advisable to describe it as new, however, until more differences are found. The color of the corollas might lead one to associate it with *A. lutea* L., but that is a vernal species, flowering about three months earlier (in the vicinity of Atlanta, the only region where I have seen it), while the plant under consideration flowers later than any other southeastern species.

* Bull. N. Y. Bot. Gard. 3: 432. 1905.

Typical *A. arborescens* is not definitely known south of the mountains of Georgia,* and the coastal plain form here discussed seems to be one of a small class of plants inhabiting the "mesophytic" forests of the Eocene region of Southwest Georgia and nearly but not quite identical with Alleghanian species. Other examples of this class are *Magnolia pyramidata* Pursh, *Thaspium barbinode Chapmani* C. & R., and *Rhododendron Cuthbertii* Small, all of which I have found in Randolph County.

BARTONIA LANCEOLATA Small, Fl. S. E. U. S. 932. 1903

This is probably identical with *B. tenella brachiata* Wood (Class-Book 586. 1861). If so this will not be the first time that a supposed new species proposed by one of the present generation of systematists has been found to have been already described as a variety by Wood, who seems to have had an exceptional faculty of recognizing previously unobserved characters in plants, though he was too conservative to describe many new species. The Vienna rules do not require any change of name in a case of this kind, however, so I will not undertake to increase the number of synonyms at present.

In studying our species of *Bartonia*, the papers by Robinson (Bot. Gaz. **26**: 46–48. 1898) and Williams (Rhodora **2**: 55–57. *pl. 15. f. 1–7.* 1900) will be found useful.

AMSONIA CILIATA Walt.

Two forms of this occur quite frequently in South Georgia, one with leaves two or three times as broad as the other. There are other slight differences, but scarcely enough to entitle both forms to specific rank, though they are distinguished easily enough and should receive some recognition in systematic works. As a rule the broader-leaved form grows in dry pine-barrens and the other on sand-hills. Correspondence a few years ago with Mr. E. G. Baker, of the British Museum, elicited the fact that the

* It is mentioned in Earle's Flora of the Metamorphic Region of Alabama (Bull. Ala. Agric. Exp. Sta. **119**: 96. 1902), but in the absence of specimens it is impossible to ascertain whether the mountain or the coastal plain form is meant. Wood may have known our plant, for his description of *A. arborescens* (Class-Book 490. 1861) fits it very well, and one of the localities cited, Macon, Georgia, is on the edge of the coastal plain and only about 100 miles from Cuthbert.

specimen in Walter's collection was a broad-leaved form (matching very closely Curtiss's *no. 2269* from the vicinity of Aspalaga, Florida, according to Mr. Baker). The narrow-leaved form is in all probability what Rafinesque described as *A. tenuifolia* (New Fl. N. Am. **4**: 58. 1836). Wood's *A. ciliata filifolia* (Class-Book 589. 1861) though inadequately described, is doubtless intended for the same thing. The description of *A. angustifolia* (Ait.) Michx., which has always been considered synonymous with *A. ciliata* Walt., might apply equally well to the narrow-leaved variety also.

A. ciliata is represented in my collections by *no. 1166*, in fruit, from dry pine-barrens in Mitchell County, Aug. 7, 1901, and the narrow-leaved form from the following counties: Dooly (*no. 577*, in fruit), Bulloch (*no. 915*, in fruit), and Laurens (*no. 2138*, in flower). The latter has also been collected along the Flint River near Albany by Dr. Small in May, 1895, and in Leon County, Florida, by Mr. Nash in September of the same year (*no. 2546*). Its total range is as yet unknown.

ANONYMOS CAROLINIENSIS Walt. Fl. Car. 91. 1788

Batschia carolinensis (Walt.) Gmel. Syst. **2**: 315. 1791.

Lithospermum carolinianum Lam. Tab. **1**: 396. 1791.

L. hirtum (Muhl.) Lehm. Asperif. 305. 1818 (and most 19th century authors).

L. carolinense (Walt.) MacMillan, Met. Minn. 438. 1892.

L. Gmelini (Michx.) Hitchcock, Spring Fl. Manh. 30. 1894 (and most subsequent authors).

Mr. Mackenzie * has recently pointed out that Lamarck's *Lithospermum carolinianum* is a synonym of *L. Gmelini*, instead of a conflicting homonym as was thought to be the case a few years ago. But the identity of Lamarck's plant is not of fundamental importance in the present case, since the specific name dates back to Walter, three years earlier, as was noted by MacMillan in 1892, but apparently by no one else who has mentioned this plant since his time. (Several other synonyms for it can be found in MacMillan's work.)

A careful scrutiny of the above synonymy will disclose several problems which do not seem to be provided for in any set of rules

* Bull. Torrey Club **32**: 501. 1905.

for nomenclature, and the exact designation of this plant will depend somewhat on the rules used. It would be beyond the scope of this paper to discuss these problems fully, but I will briefly indicate some of them for the benefit of those who are more interested in such matters.

In the first place, Walter had quite a number of *Anonymos* genera, as is well known, and in several of them he used the specific name *caroliniensis*. The first *Anonymos* of course invalidates all the rest, but shall the first one be recognized? (It happens to be a good genus, and was named *Tubiflora* by Gmelin and *Elytraria* by Vahl. The only species included in it by Walter bore the specific name in question.) Second, does the first *Anonymos caroliniensis* invalidate all the rest (ours among them)? Third, shall the original spelling of the specific name be maintained? Fourth, if *Anonymos caroliniensis* is a homonym, does that affect the validity of *Batschia caroliniensis* Gmel. and *Lithospermum carolinianum* Lam.? Fifth, which of the two last-mentioned names is older? Sixth, if the third and fourth questions are answered in the negative, shall we call our plant *Lithospermum carolinianum* Lam., *L. carolinianum* (Walt.) Lam., or *L. carolinense* (Walt.) MacM.?

The last problem could be partly circumvented by recognizing Gmelin's genus *Batschia*, which was founded on this species alone, and seems as distinct as many other genera now recognized.

VERBENA CARNEA Med.; Schauer in DC. Prodr. **11**: 545. 1847

? *Phryma caroliniensis* Walt. Fl. Car. 166. 1788; Gmel. Syst. **2**: 921. 1791.

V. caroliniana Willd. Sp. Pl. **1**: 119. 1798; Pursh, Fl. Am. Sept. 417. 1814; Nutt. Gen. **2**: 40. 1818; Ell. Bot. S. C. & Ga. **2**: 99. 1821.

V. caroliniana "L."; Michx. Fl. **2**: 14. 1803; Wood, Class-Book 537. 1861.

"*V. caroliniana* Michx."; Chapm. Fl. So. U. S. 307. 1860; Gray, Syn. Fl. **2**: 336. 1886.

"*V. Carolina* L."; Mohr, Contr. U. S. Nat. Herb. **6**: 693. 1901.

V. carolinensis (Walt.) "Gmel."; Small, Fl. S. E. U. S. 1009. 1903.

(Not *V. Carolina* L. Sp. Pl. ed. 2. 29. 1762, nor *V. caroliniana* Gmel. Syst. **2**: 42. 1791, both of which are based on *V. carolinensis* Dill. Hort. Elth. 407. *pl. 301. f. 388.* 1732.)

Stylodon scabrum Raf. Neog. 2. 1825.

A study of the synonymy of this characteristic southeastern coastal plain plant has revealed a surprising amount of carelessness in citation of names, as has been the case with several other species having a similarly restricted range. The *Verbena Carolina* of Linnaeus was based on a plate and description by Dillenius, which cannot be referred to our plant, and a brief description by Ray, which may belong to the plant in question, as suggested by Gray, though the evidence is insufficient. The first valid name under *Verbena* seems to be *V. carnea*, as above indicated, though Rafinesque 22 years earlier had made this same plant the type of a new genus, *Stylodon*. I am by no means convinced that Rafinesque's genus is not a good one, so I will not cumber synonymy by transferring his specific name to *Verbena*.

Clinopodium georgianum nom. nov.

Thymus carolinianus "(Walt.)" Michx. Fl. Bor. Am. **2**: 9. 1803.

Calamintha caroliniana (Michx.) Nutt. Gen. **2**: 39. 1818; Sweet, Hort. Brit. 315. 1826.

C. caroliniana "Sweet"; Benth. in DC. Prodr. **12**: 229. 1848; Chapm. Fl. So. U. S. 317. 1860; Gray, Syn. Fl. **2**: 360. 1886; Jackson, Ind. Kew. **1**: 375. 1895.

C. caroliniana "Swartz"; Wood, Class-Book 548. 1861.

Melittis caroliniana Spreng. Syst. **2**: 700 (in part). 1825.

Melissa caroliniana (Michx.) Benth. Lab. 388. 1834.

"*Clinopodium carolinianum* Mill."; Jackson, Ind. Kew. **1**: 565 (as syn.). 1895.

C. carolinianum (Michx.) Heller, Cat. N. Am. Pl. 7. 1898; Small, Fl. S. E. U. S. 1043. 1903. (Not of Mill. Gard. Dict. ed. 8. 1768.)

C. carolinianum "(Walt.) Kuntze"; Mohr, Contr. U. S. Nat. Herb. **6**: 700. 1901.

Thymus grandiflorus Sims, Curt. Bot. Mag. **25**: *pl. 997.* 1807.

Calamintha grandiflora (Sims) Pursh, Fl. Am. Sept. 414. 1814; Ell. Bot. S. C. & Ga. **2**: 93. 1821.

(Not *Melissa grandiflora* L., *Calamintha grandiflora* (L.) Moench *Clinopodium grandiflorum* (L.) Kuntze, a European species.)

The bibliographic history of this handsome little southern shrub is even more complicated than in the case of the *Verbena* just mentioned. The plant seems to have been first noticed "*in Carolina et Georgia, secus amnem Savannah, ad urbem Augusta*," by Michaux, who named it *Thymus carolinianus*, supposing it to be the same as Walter's *Thymbra? caroliniana*. But according to Elliott, Walter's *Thymbra* was identical with the type of his own new genus *Macbridea*.* (Walter's description alone would scarcely suffice to identify the plant, but Elliott may have had some other evidence.) Sims, however, figured a plant which is clearly the same as ours, but identified it confidently with Walter's, and changed the specific name so as not to conflict with Michaux's *Thymus carolinianus*, whose identity he doubted.

Pursh and Elliott placed the species in *Calamintha*, using Sims's specific name, regardless of the fact that Moench had used the same combination twenty years earlier for a European plant. Nuttall was the first to combine *Calamintha* with Michaux's specific name, but Bentham, Chapman, Gray and the Kew Index credit this binomial to Sweet, notwithstanding the fact that Sweet plainly refers to Nuttall, and Nuttall's citation and description are perfectly satisfactory.

In 1891 Kuntze transferred all our species of *Calamintha* to *Clinopodium*, and noticing that there was already a *Clinopodium carolinianum* (described by Miller long before Michaux's *Thymus* or even Walter's *Thymbra*), changed the specific name of our plant, as he thought, but erred (presumably) in making it synonymous with Walter's *Thymbra;* so if we accept Elliott's views, Kuntze's *Clinopodium Walterianum* becomes a synonym of *Macbridea*. A few years later Mr. Heller fell into the trap that Kuntze avoided, and took upon himself the credit for the supposed new combination *Clinopodium carolinianum*. Dr. Mohr in

* MACBRIDEA PULCHRA Ell.; Nutt. Gen. **2**: 36. 1818; Ell. Bot. S. C. & Ga. **2**: 86. 1821; and most subsequent authors.
Thymbra? caroliniana Walt. Fl. Car. 162. 1788. (*fide* Ell.)
Melittis caroliniana Spreng. Syst. **2**: 700 (in part). 1825.
Macbridea pulchella Benth. Lab. 505. 1834; DC. Prodr. **12**: 435. 1848.
Clinopodium Walterianum Kuntze, Rev. 516. 1891 (excl. syn. Sweet).

1901 seems to have taken for granted that Kuntze was the author of this combination as of many others in the same genus.

Just what plant Miller had in mind is an open question. In the Kew Index his *Clinopodium carolinianum* is made a synonym of "*Calamintha caroliniana* Sweet," but his description does not justify this disposition of it, and it would be a remarkable coincidence if it did. So as long as *Clinopodium* is accepted as the name of this genus both specific names which have been given to our plant are preoccupied, and I have ventured to rename it in honor of the other of the two states where Michaux first saw it, which is centrally located with respect to the known range of the species. For those who would retain *Calamintha* the specific name *caroliniana* is still available, if we disregard Michaux's reference to Walter, or accept Sims's views.

Cytological changes accompanying secretion in the nectar-glands of Vicia Faba

CHARLES RUPERT STOCKARD

(WITH PLATES 10 AND 11)

The cytological changes accompanying secretion have been studied in a number of animal glands with the result that no very obvious degree of uniformity was observed. There are some cases involving the actual destruction of the secretory cells, while in others the integrity of the cell is perfectly preserved. The amount of work on the glandular cells of plants has not been so extensive, yet, among the observations recorded, we find described a considerable diversity in the sequence of events taking place within nucleus and cytoplasm. The nuclei in the case of some glands remain intact but change considerably in their staining reactions, in others the nuclear walls become ruptured and their contents discharged into the body of the cell; the cell-walls themselves in some instances are recorded as being dissolved, and in one case, *Drosera*, the chromatin of the nucleus becomes arranged into a definite number of V-shaped chromosomes during secretion. There are also instances of observers working on similar objects obtaining entirely different results. We are thus forced to recognize the discordant condition existing at present in this field.

Having the above results in view Prof. Francis E. Lloyd kindly suggested to me that I study the cytological changes in the secretory cells of a nectar-gland on the stipules of *Vicia Faba*, the horse bean. It is, therefore, a pleasure to take this opportunity of expressing my indebtedness to Professor Lloyd for his many valuable suggestions and kindly criticism during the progress of this research.

I hoped through the study of these glandular cells to be able to throw some light on the origin of the secretory product and if possible to determine what nuclear and cytological changes accompanied its production and discharge from the gland-cells.

Further, I wished to determine what connection or relation exists between the nuclear and cytoplasmic changes and to find what constituent of the nucleus should it prove to be active in the process is most concerned. The observations described below are designed to attack these questions, though it is recognized that the results rather indicate the need of further careful and exhaustive study than give definite answer to these queries.

METHOD AND MATERIAL

The nectar-glands on the stipules of *Vicia Faba* are beautifully adapted for study; since from the terminal bud to the old mature leaves may be obtained all stages in the development of these glands as well as the entire cycle of secretory action. The living material flourishes in the greenhouse during winter, so that preparations may be made from time to time with little trouble.

Realizing that the methods of fixation and staining in work of this type are open to so much criticism, I have taken all practical precautions against errors from this source. First, observations as far as possible on nuclear positions *et cetera* were made upon free-hand sections of the living glands, and in the second place a large number of fixing and staining solutions were used and the results compared.

The glands were cut from the stipules with a border of non-glandular tissue, thus insuring the presence of all parts of the gland in the preparation, and further facilitating a comparison between gland-cells and ordinary tissue-cells. The material was then, while in the natural condition, quickly placed in the fixing fluids; those employed being Gilson's fluid, picro-acetic, chromo-acetic, picro-corrosive, picro-aceto-sulphuric, alcohol acetic, sublimate acetic, and picro-sulphuric, with the following success. The Gilson's fluid gave most satisfactory preparations, the nucleus and cytoplasm being in apparently perfect condition. The picro-acetic and chromo-acetic gave fairly good results, and the picro-corrosive used by Reed also proved favorable though inferior to Gilson's fluid. Picro-aceto-sulphuric was rather uncertain, though in some cases fairly good preparations were obtained by its use. Alcohol acetic, sublimate acetic, and picro-sulphuric were all unfavorable. The series for study was then fixed with Gilson's,

picro-acetic, and picro-corrosive, all giving good results and supplying valuable means of comparison. The same precaution was resorted to with the stains, and from the number tried those best adapted to this material were selected.

Auerbach's stain (methyl green and acid fuchsin) was extensively used for studying the cell-contents, as it gives a beautiful differentiation of nuclear substances, and differentiates clearly the chromatic granules of the nucleus from the cytoplasmic granules about the nuclear wall. Heidenhain's iron-haematoxylin with congo red as a counter-stain gave far the clearest preparations and is a most valuable stain, although Reed in criticizing Torrey's results, objects on the ground that it does not differentiate between acid and basic elements of the cell. This is an objection in itself open to criticism, as after the use of fixatives we should not depend on any one stain for such differentiation, and probably Auerbach's stain, which Reed failed to use, is best for such purposes. Torrey, himself (page 429), mentions this same objection to an iron-haemotoxylin and states that on this account he resorted to the use of Auerbach's method for comparison.

Eosin-toluidin blue as recommended by Reed was successfully tried. Eosin and polychrome methylin-blue used separately gave good preparations, while mixed as Romanowsky's stain the results were poor. Throughout this study the artificial conditions of stained preparations were always kept in mind and comparisons continually resorted to so that if errors do exist I believe they should be attributed to other causes.

OBSERVATIONS ON THE LIVING GLAND

The glands are situated on the stipules of the leaves and when mature appear as small dark-red spots, one on each stipule rather near its base.* The immature glands found in the terminal buds are tiny white spots on the pale-green stipules, and the gland is several days old before it becomes colored. They are more conspicuous on the lower or outer surface of the stipule, being less distinct and velvety in appearance on the upper side, the side, namely, on which the secretion occurs. The velvety appearance is due to the presence of the hairs described below. The secretion

* First mentioned by Sprengel, Entd. Geheimniss 357. 1793.

is a limpid watery nectar found usually in the early morning as a droplet on the surface of the gland. This seems to accord with Wilson's observation that these glands may be made to secrete by the stimulus of illumination.

When the gland is examined microscopically it is seen to be perfectly flat, lacking any infolding, and composed of several kinds of cells (FIGURE 1). The inner or lower cells and the epidermal layer seem slightly if at all modified in form, while the epidermal ones are rather more columnar in shape than are those of the general tissue-epidermis. Two kinds of hairs are found on the surface of the glands; one a long slender conical body composed of two cells (FIGURE 2), a small slightly modified basal cell and a long conical apical cell which forms the main body of the hair. This hair is pale-greenish or colorless during life and has a very thick wall. Its function is probably sensitive, though this could not be definitely determined. Haberlandt has suggested that these hairs in another species serve to hold the secretion and prevent its falling off, but I fail to understand, on account of their scarcity on the gland-surface, how they could perform such a function. The other hairs (FIGURE 3) are entirely different in shape, being somewhat club-like, and consisting when mature of five cells. These cells are definitely arranged with a single basal cell usually somewhat smaller than the rest, and four larger cells placed in two pairs one immediately above the other. The four cells might be described as forming the four quarters of an ovate spheroid. These cells contain the secretion-products just as those in other parts of the gland and their color and appearance in life are due to this substance. These will be termed nectar-hairs for the sake of convenience. De Bary states that the glandular properties of these cells have not been observed, but their close similarity to cells of other parts of the glandular area makes it obvious that in younger glands at least these hairs do serve the ordinary secretory functions. The fact that they arise directly from the epidermal gland-cells further suggests their glandular properties.

The color and color-changes in the gland-cells are most interesting. When examining free-hand sections of the living material one finds a brilliant red and a deep blue color arranged in various patterns. At times the epidermal layer with the nectar-hair cells

will be red while the lower cell-layers are blue. Again, layers of red and blue cells may alternate for as many as four or five layers or rows. The contents of the hair-cells are actually at times of different colors, the distal pair being red or blue while the proximal pair are, conversely, blue or red. In mature glands many of the outer tips or distal cells of the nectar-hairs contain a colorless liquid. Thus the cell-contents lose their pigmentation before being thrown out. Often the entire gland is found to be of one color, either blue or red.

This shifting color-scheme suggested to me that possibly the color depended upon the conditions of acidity or alkalinity in the different cells. Therefore experiments were tried in which acid and basic solutions were passed over the glands while on the slide and the responses proved that the color did depend upon the cell's chemical reaction. When a weak HCl solution was passed over a gland containing alternate rows of blue and red cells all the blue cells became red, just as litmus would respond to acid. If dilute NaOH was now applied until the liquid on the slide became alkaline the cells all changed to blue. One is able to alternate this color-change back and forth for a number of times, provided the acid solution is not allowed to remain for too long a time, as the cell-substance is soluble in it, finally dissolving out. This suggests Bonnier's statement that an invertin which dissolves the secretion-products is to be found in glands, and Lloyd also suggested that this invertin might occur in certain non-green cells in the pericycle of *Pteridium* nectar-glands. In the glands of *Vicia Faba* the nuclei in most cases also become red on meeting the acid and thus indicate that they contain material similar to the secretion-substance. On adding the base the nuclei became clear and difficult to see having lost their pinkish acid response.

Testing with Fehling's solution for the variety of sugar present in the secretion substance, cane sugar was found.

HISTOLOGY AND DEVELOPMENT

A. *Structure.* — Studying these glands as stained preparations, one sees very little histological difference between the cells of the gland-area and those in adjacent parts of the stipule. The deeper layers of cells in the gland are strikingly similar to cells of the

same layer in other portions, except for the fact that they rarely contain chlorophyl-granules and that their nuclei seem a little less irregular in form, tending to be as a rule spherical. Lloyd was probably correct in his supposition that the cells lacking chlorophyl in the foliar nectar-glands of *Pteridium* were functional in the secretory process. The epidermal cells of the gland are more columnar in form than those of the general epidermis, being sometimes more than twice as long as broad. The hairs mentioned above are really the only highly specialized structures to be found in these glands. The basal cell of the conical hair (FIGURE 2, *bc*) is often inferior in size to any other cell present, and its contents at times appears very scanty. The tip, or conical cell, of this hair is highly modified, having an enormously thickened wall which in many cases stained diffusely with the methyl green of Auerbach's stain. In size this cell is more than twice the length of any other present, and somewhat broader at its base than the epidermal cells.

The more numerous hairs which for convenience have been termed nectar-hairs, are constructed as described above. The basal cell in this case (FIGURE 3, *bc*) is likewise somewhat smaller than the neighboring cells, but its walls are not so thick as the upper epidermal wall; otherwise it is not remarkable. The outer walls of the remaining four cells of the hair are thin, and the wall forming the distal dome of the hair is very much thinner than elsewhere. The inner partition-walls which separate the four cells are also thin, though usually appearing thicker than the outer ones. As before stated, the contents of these cells is very much like that of the other cells of the gland, except in cases of old glands, when the general gland-cell material stains lightly with the plasma-stains, while these hairs are filled with substances tending to take the nuclear dies. The nuclei of hair-cells (FIGURE 13) are similar to those of other cells, being vacuolated and changing with age in much the same manner.

I consider that the gland proper consists of the club-shaped hairs and the several layers of cells below these, whereas the conical hairs are accessory, being found in no other part of the stipule.

B. *Development.* — Since the general glandular tissue resembles in structure that of other portions of the stipule, little of especial note is expected in its development. The case, however,

of the modified hairs is much more interesting. In very young glands before their contents becomes colored, only the nectar-hair type exists, a few of these being arranged in a central group. As development proceeds new hairs are formed around these as a center until the gland has attained its mature size and color. The nectar-hair is formed in the following manner: the outer wall of an epidermal cell protrudes above the surface to a height about equal to its former depth (FIGURE 4), and its nucleus, which up to this time is still in the resting condition, now divides mitotically (FIGURE 5) into two and thus forms the first cell of the hair. The parent and daughter cell again divide horizontally and so give the hair three cells arranged in a vertical row (FIGURE 6). A vertical division of the two upper, or distal, cells then forms the four-celled arrangement of the mature hair (FIGURE 3). This latter process was not actually observed in my material, but is easily inferred from the stages which do exist.

The conical hairs (FIGURE 2) are found only in glands that have assumed the mature color, and are always far less abundant than the above type. They also arise from an epidermal cell, and in this case the epidermal wall retains its thickness while pushing up to form the heavy cone of the hair. With the development of this type of hair the gland has reached its mature condition.

NUCLEAR AND CYTOPLASMIC CHANGES DURING SECRETION

All observations recorded in these notes were made with Leitz 1/16 oil-immersion objective and number three ocular with the tube-length 170 mm.

(*a*) The youngest glands taken from the terminal buds present the following appearances (FIGURES 7 and 14). The true nucleoli, or plasmosomes, take the acid stains, thus giving with Auerbach's or Congo red a delicate pink color, and they are usually surrounded by large vacuoles. Often two or more plasmosomes are found in the same nucleus (FIGURE 7). They differ slightly in size in the various cells, as do also the vacuoles about them. In some cases the vacuole disappears almost entirely, this being often true of the nuclei in the young nectar-hair cells (FIGURE 13, *A*). The chromatin is granular in structure rarely giving the appearance of a thread-like arrangement. These granules in some nuclei are

closely packed, causing them to stain very heavily, while other nuclei in nearby cells contain much less chromatic substance (FIGURE 12). The nuclei of the gland-cells are somewhat larger and more spherical than those found in the adjacent tissues.

The cytoplasm appears finely granular in structure and is often more or less vacuolated. The cytoplasm in the hair-cells does not differ noticeably from that in other cells of the gland. It is usually densest about the nuclei and never contains any nuclear staining, or cyanophil, material.

(*b*) Considering now a gland that is slightly older or more mature than the former, being the next lower on the stem of the terminal bud. Here are also found (FIGURES 4 and 15) vacuoles of various size about the plasmosomes. The chromatin is again granular as a rule, but many nuclei preparing for division are in spireme stage. In some again the granules are densely arranged while in others the chromatic substance is less abundant.

The cytoplasm is granular in appearance, with numerous vacuoles, and is densest about the nuclei. In a few of the central and therefore oldest nectar-hairs the granules of the cytoplasm have become cyanophil and stain heavily. The walls of these hairs have slightly shriveled. All of the nuclei in the nectar-hairs and the epidermal cells are situated near the cell-center, while in lower layers the nuclear position is not so constant.

(*c*) The cells of the next older gland on the stem are still colorless. The nuclei have large vacuoles about the plasmosomes (FIGURES 8, 9, and 11). The chromatin is granular but more diffuse or not so densely arranged as in the two younger, some nuclei being thin and pale. The nuclei of the nectar-hairs are much poorer in chromatin than those in similar parts of the glands above (FIGURE 13, *B*). The plasmosomes are about equal in size in these three stages of the glands.

The cytoplasm is coarsely granular, being again dense around the nuclei, and contains a few basic staining or cyanophil granules. There is no chlorophyl in any of the cells of these three glands, which appear white in life.

(*d*) The youngest gland containing colored material. The nuclei are vacuolated about the plasmosomes (FIGURE 16), but as a rule those of the nectar-hairs do not contain as large vacuoles

as are found in other parts. The chromatin is arranged much as in the three former cases: in some nuclei the granules are closely packed, in others loosely.

The cytoplasm now becomes denser and more coarsely granular, staining more heavily than in the three former glands. The nucleus is again, as a rule, surrounded by a dense cytoplasmic arrangement. The granules of the general gland-cells take the plasma-stains, while many in the nectar-hairs stain with the nuclear dies.

(*e*) Newly matured glands, slightly older than the above. The nucleus is still vacuolated about the plasmosomes. The chromatin is granular and arranged much as above described, in some instances being closely packed and in others thinly. Some nuclei in the lower cell-layers take the plasma-stains, seeming to have lost their chromatic character. The nuclear positions tend toward the cell-center (FIGURE 10).

The cytoplasm is now rather densely granular, *the granules of the general gland-cells taking the plasma-stains, while those of the nectar-hairs stain with the nuclear stains, particularly the methyl green of Auerbach's stain.*

(*f*) Old but still secreting glands. The nuclei of these glands are slightly shrunken and lie against the cell-walls (FIGURE 17). The vacuole about the plasmosome is not so large and in some is absent; the granular chromatin is as a rule closely arranged. The nuclei in adjacent tissue-cells are often very small, sometimes apparently absent, and in many cases extremely elongate in form. In fact there is a slight difference in all stages between gland-cell nuclei and general tissue nuclei, the former being as a rule, but not always, larger and tending more toward the spherical form.

The cell-contents is at this time particularly interesting in its structure, and in all cases is granular in appearance. The cells of the epidermal and lower layers stain very palely with plasma-stains, while the nectar-hairs stain deeply with nuclear dies such as methyl green, iron haematoxylin, and others. In some cases the granules of the cell stain so densely as almost to hide the nucleus which responds to the stain in exactly the same manner as do these granules (FIGURE 17). The contents of the basal cell of the conical hairs takes the plasma-stains, thus differing in its staining reaction from the nectar-hair cells.

COMPARISON WITH OTHER OBSERVATIONS

Co nparing the above changes with those observed in various gland-cells it is difficult to agree in all points with any one author, but on the other hand a study of the results forces one to recognize that secretion in the cell is a process that may be accomplished in many different ways. To quote the statement made in *An American Text-book of Physiology*, on this subject, by Howell: "In the sebaceous secretion the cells seem to break down completely to form the material of secretion; in the formation of mucus by the goblet-cells of the mucous membrane of the stomach and intestines a portion of the cytoplasm after undergoing a mucoid degeneration is extruded bodily from the cell to form the secretion; in the mammary glands a portion of the substance of the epithelial cells is likewise broken off and disintegrated in the act of secretion, while in other glands the material of the secretion is deposited within the cell in the form of visible granules which during the act of secretion may be observed to disappear, apparently by dissolution, in the stream of water passing through the cell. Facts like these show that some at least of the products of secretion arise from the substance of the gland-cells and may be considered as representing the results of a metabolism within the cell-substance. From this standpoint, therefore, we may explain the variations in the organic constituents of the secretions by referring them to the different kinds of metabolism existing in the different gland-cells." This statement relating to animal secretion might with slight alterations be applied equally well to that of plants.

It is now pertinent to consider some of the later contributions to the cytology of secretion among plants and animals and compare the results indicated with the case at hand. Mathews ('99), working on the pancreas cell of various animals, observed the following facts. He found that these cells contained in their basal portions a ball of thread-like fibers which is termed pancreatic mitosome, or "Nebenkern." During secretion these threads, which extend into the upper portions of the cell, break up into the granules which finally form the secretion-substance. The fibrils were found in a number of cases to terminate in, or over, the peripherally placed chromatic masses of the nucleus. Thus Mathews concluded for this and other reasons that the nucleus was passive in the actual

process of *secretion* ("the process of the discharge from cells of their metabolic products"), but was active in the manufacture of the secretion-substance, which process he termed "*hylogenesis.*" I feel sure that in the case of the plant gland-cells which I have studied this statement holds equally well. Since no *Nebenkern* or fibers were found to exist in these cells, no direct morphological relation could be established between the nucleus and the secretion-product, although the staining reactions and the occurrence of the granules lead one to think that the nucleus and particularly its chromatic portion is active in the manufacture of the secretion-products. Mathews further finds that during secretion the nucleus moves from the base to the center of the cell, and during rest it returns to a position at the base; thus the nucleus in secretion is passive, merely changing position, due possibly to currents in the cell, but undergoing no structural changes. He states that he finds no trace of a substance of any kind escaping from the nucleus, nor did I observe any such phenomenon in the nectar-glands under consideration. His final position may be seen in this quotation: "I am, therefore, of Nussbaum's opinion, that the changes in the nuclei of secreting cells are passive, and that the nucleus plays no active part either in secretion or zymogenesis."

Harrington ('99) found in the calciferous glands of the earthworm that the disintegration of cytoplasm is in direct ratio to the amount of lime produced, and, as stated in my observations, as the hair-cells become loaded with the secretion-product the cytoplasm of the general gland-cells becomes much paler and therefore more tenuous. At the height of constructive activity, when the cell is ready for the changes which will result in the formation of lime crystals, Harrington finds that the cytoplasm continues to increase in extent, becomes less dense, and vacuoles appear here and there, the nucleus becomes decidedly vesicular, the nucleolus large and densely staining. This description would apply to the cells figured in most contributions on secretion, and in FIGURE 16, which is a gland at the height of secretion, these structures are to be seen.

Schniewind-Thies ('97) studied the nectar-glands in a large number of plants and found that the nuclei of secretion-surfaces are everywhere distinguished from those of the parenchyma by their greater contents of chromatin. She found in secreting cells

that the nucleus sometimes assumed amoeboid shapes and in some entirely disappeared. I find nothing to correspond with these descriptions in my own material, although the slight diversity of form may perhaps be due to amoeboid motion. She further observed that the nucleus in one form lost its response to stains, changing from cyanophil to erythrophil, and as I have recorded above in a few cells of mature glands this staining reaction occurred, but in my material it is rather the exception than a general condition, and was found principally in the deeper layers of the gland, Schniewind-Thies also observed that at the height of secretion the cells are much swollen, which to a less degree is the case in this gland, as is seen by comparing FIGURES 9, 11, and 16 with 17, all drawn at the same magnification.

Huie ('96), studying the changes of the cell-organs of *Drosera*, finds one most noteworthy result; on page 424 she states, "The aggregation of the nuclear chromatin into a definite number of V-shaped segments — eight in *Drosera* — proves that such a change is not a feature of characteristic mitosis, but simply a sign of great activity in the nuclear organs." Similar phenomena have been observed in animal glands, but a constant number of these chromosomes was not found. Huie's observation is striking if the chromosomes do actually exist in a definite number and this number differs from that typical during mitosis. Such would seem to show that chromatin had the power to arrange itself into different sets of chromosomes for physiological and morphological purposes. In my preparations I was unable to find any such chromatic arrangement at any stage of secretion. She also found cytoplasmic changes in staining reactions; during secretion the cyanophil cytoplasm disappeared. The cyanophil chromatin increased during this time and after being thrown out from the nucleus it gave rise to new cyanophil cytoplasm. After long-continued secretion the cyanophil cytoplasm was entirely changed into a scanty erythrophil cytoplasm. This seems to establish a comparable relation between nuclear and cytoplasmic material to that which I have shown in the nectar-glands of *Vicia Faba*. And as Torrey ('02) suggests, a possible explanation of this phenomenon may be that some organic acid is formed during the great metabolic activity of the cell.

Torrey studied the changes accompanying the secretion of diastase in maize and barley. He found as I do that the secretion was intermittent, but held the opinion that the secretion-material was given out as granules from the nucleus through breaks in its wall. The nucleus according to Torrey gradually became loaded with granular material and finally stained a uniform black, the presence of the granules being recognized only by its corrugated edge. The pressure finally bursts the nuclear membrane and the granules stream out in rows, collecting later near the upper, or outer, surface of the cell. This is quite a different process from that recorded by most other writers, and certainly no such nuclear changes occur in the gland which I have studied. Later Reed ('04) has worked on the same material and reached entirely contrary conclusions. In maize he fails to find any indications of granules being given out directly through the nuclear membrane.

Lloyd ('01) investigated the nectar-glands occurring on the leaves of the common brake, *Pteridium*. The position of this gland is similar to that of the one under consideration, and he suggested as the possible function of such organs that the actively secreted sugar may act as a carrier for some other substance in the nature of an excretion. Bonnier had shown that other substances than the secretion-products were thrown off in small quantities from several glands. Lloyd attributed to the cells of the pericycle the power of passing the soluble carbohydrates from the moving sap into the gland, and thus accounted for the greater development of the pericycle. These pericycle cells contain no chlorophyl, and I should rather think that they are actually active in secretion or, in other words, are truly a part of the gland itself; such a view would account equally as well for their greater development in the glandular area.

A felt of dark-colored fungal hyphae was in some cases observed on the surface of the *Pteridium*-glands. I have also found a fungus growth not uncommon on the older glands of *Vicia*. Lloyd offers the apposite suggestion that the nectaral surface is a constant infection-point, the sugary fluid acting as a nutrient medium.

In the case of the nectar-gland under consideration, one is forced to choose the position that *the nucleus takes an important*

part in the manufacture of the secretion-substance, but plays a more or less passive rôle in the essential process of secretion. Further, the cytoplasm also undergoes marked changes during the stages of glandular secretion. It first becomes more vacuolated, and later becomes more coarsely granular, and finally in the nectar-hairs densely granular, at the same time changing its staining reaction from erythrophil to cyanophil. Finally, one must admit that these later changes of the cytoplasm, at least, are largely controlled or influenced by the nucleus and possibly by its chromatic constituent.

SUMMARY

1. The nectar-glands on the stipules of *Vicia Faba* contain rows, or layers, of cells whose contents have different chemical reactions, as is shown in life by their different colors.

2. This difference in chemical reaction indicates very probably a difference in metabolic activity of the cells, since those of definite rows have a similar reaction. The color-response of these cells to acids and bases is the typical litmus change ; acids causing the cell-contents to become red, bases changing it to blue.

3. The cells of young glands differ but slightly from the general tissue-cells.

4. The nuclei are granular in structure, often coarsely vacuolated, with one or more plasmosomes surrounded by vacuoles. Their shape tends toward spherical, but in old glands they become shrunken and slightly irregular in form.

5. The position of the nucleus in the secreting cells varies greatly, but is more often near the center of the cell.

6. The nucleus is never observed to give out granular material to the cytoplasm, though evidence is strongly in favor of the supposition that it does transmit substance to the cytoplasm which finally forms, or causes to form, granules and these take during later stages the nuclear stains.

7. In rare cases the nucleus loses its chromatin in older glands and takes the plasma-stains, staining with the acid fuchsin of Auerbach's.

8. The cytoplasm undergoes changes in structure as secretion progresses, at first becoming vacuolar, then slightly granular, still taking the plasma-stains, and then finally becoming densely granular and staining with the nuclear dies.

9. There is evidence to indicate that the cytoplasmic changes are controlled by the nucleus.

10. The nucleus seems to be the center of metabolic activities participating in the formation of the secretion-substance but playing a passive rôle in the actual process of *secretion.*

DEPARTMENT OF BOTANY,
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Explanation of plates 10 and 11

All figures are from camera sketches. Fig. 1 with Leitz $\frac{1}{6}$ objective and three ocular. Figs. 2, 3, and 6 with $\frac{1}{1.5}$ objective and 3 ocular. Tube-length 170 mm.

PLATE 10

FIG. 1. Outline of the gland-area, showing the relation of its parts. *ch*, conical hair; *nh*, nectar-hair; *epc*, epidermal cell-layer; *lc*, lower cells.

FIG. 2. Conical hair. *bc*, basal cell; *ac*, apical cell; *n*, nucleus of apical cell.

FIG. 3. Enlarged nectar-hair. *bc*, basal cell; *nc*, nectar-cell.

FIG. 4. Epidermal cell preparing to give rise to the hair; note the up-pushing of epidermal wall and nuclear position. *cw*, cell-wall.

FIG. 5. Similar cell to Fig. 4. in mitosis to give rise to the first cell of the hair.

FIG. 6. Immature nectar-hair, showing the three-cell stage. *bc*, basal cell.

FIG. 7. Nuclear and cytoplasmic structure of the cells in the youngest gland-tissue. *ep*, indicates the position of epidermal cells.

PLATE 11

FIGS. 8, 9, and 11. Immature gland-cells, before their contents becomes colored.

FIG. 10. Mature epidermal gland-cell, shortly after secretion had begun.

FIG. 12. Cells of youngest gland, showing enormous vacuoles and scarcity of chromatin.

FIG. 13. Three stages of the nectar-hair nuclei. *A*, nucleus of very young hair. *B*, nucleus of hair in next gland down the axial stem. *C*, nucleus of hair in gland just becoming mature.

FIG. 14. Youngest gland-cell preparing to form hair, showing cytoplasmic arrangement and nucleus at this stage.

FIG. 15. Cells of immature gland showing numerous plasmosomes in the nuclei.

FIG. 16. Newly matured gland, first formation of large granules in the cytoplasm.

FIG. 17. Secreting hair of an old gland, showing the marked contrast between the staining of hair-contents and of basal and epidermal cell-substance. The hair stains heavily with nuclear dies, so that the nuclei of its cells cannot be certainly determined.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1905)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions their kindness will be appreciated.

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